Announcements

- 1^{st} EXAM on *Tuesday, Feb. 14!*
- Homework for tomorrow…
  - Ch. 28: CQ 3, Probs. 12, 34, & 37

  26.40: a. $E = KQ/(r^2-L^2/4)$ b. Lim_{r>>L} E ->KQ/r^2 c. E = 9.8 x 10^4 N/C
  CQ4: a. same b. same
  28.2: 2.7 x 10^6 m/s
  28.4: 2.5 x 10^4 m/s
- Office hours…
  - MW 10-11 am
  - TR 9-10 am
  - F 12-1 pm
- Tutorial Learning Center (TLC) hours:
  - MTWR 8-6 pm
  - F 8-11 am, 2-5 pm
  - Su 1-5 pm

Chapter 28

The Electric Potential

(*The Electric Potential*)

Last time…

Electric Potential Energy between 2 pt. charges…

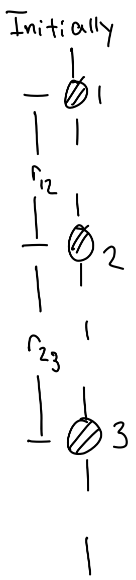
$$\boxed{U_{elec} = \frac{Kq_1q_2}{r}}$$

i.e. 28.4: Launching an electron

Three electrons are spaced 1.0 mm apart along a vertical line. The outer two electrons are fixed in position.

a. Is the center electron at a point of stable or unstable equilibrium?

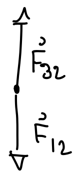
b. If the center electron is displaced horizontally by a small distance, what will its speed be when it is very far away?



$q_e = e = 1.6 \times 10^{-19}\,C$

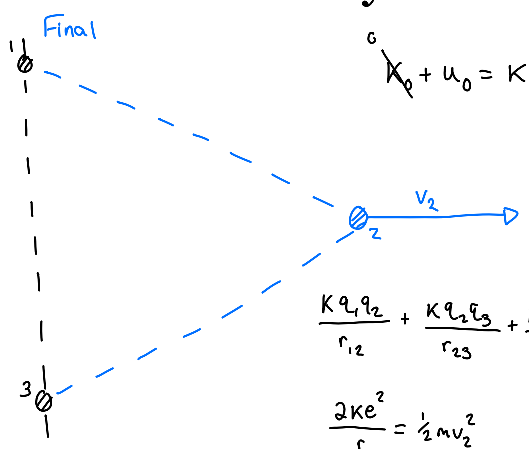
$m = 9.11 \times 10^{-31}\,kg$

$r_{12} = r_{23} = 1.0 \times 10^{-3}\,m$



$\vec{F}_{32} = \vec{F}_{12}$

$\vec{F}$



$\cancel{K_0}^{\,0} + U_0 = K_1 + \cancel{U_1}^{\,0}$

$\frac{Kq_1q_2}{r_{12}} + \frac{Kq_2q_3}{r_{23}} + \cancel{\frac{Kq_1q_3}{r_{13}}}^{\,0} = \frac{1}{2}mv_2^2$

$\frac{2Ke^2}{r} = \frac{1}{2}mv_2^2$

$\frac{4Ke^2}{r} = mv_2^2$

$\frac{4Ke^2}{rm} = v_2^2$

$v_2 = \sqrt{\frac{4Ke^2}{rm}}$

28.4: The Electric Potential

$$\vec{F}_{on\ q} \longrightarrow \vec{E} \equiv \frac{\vec{F}_{on\ q}}{q}$$

Force on *q*, due to some *source charge*

Electric field, due to some *source charge*

$$U_{q\ +\ sources} \longrightarrow ?$$

Potential energy between *q* & *source*

Potential energy per *charge?*

28.4: The Electric Potential

$$\vec{F}_{on\ q} \longrightarrow \vec{E} \equiv \frac{\vec{F}_{on\ q}}{q}$$

Force on *q*, due to some *source charge*

Electric field, due to some *source charge*

$$U_{q\ +\ sources} \longrightarrow V \equiv \frac{U_{q\ +\ sources}}{q}$$

Potential energy between *q* & *source*

Potential of *source charge*

The Electric Potential

$$\boxed{V \equiv \frac{U_{q+sources}}{q}}$$

or

$$\boxed{U_{q+source} = qV}$$

Electric Potential

$V = \frac{U_{s+}}{q}$ $\quad U_{s+} = qV$

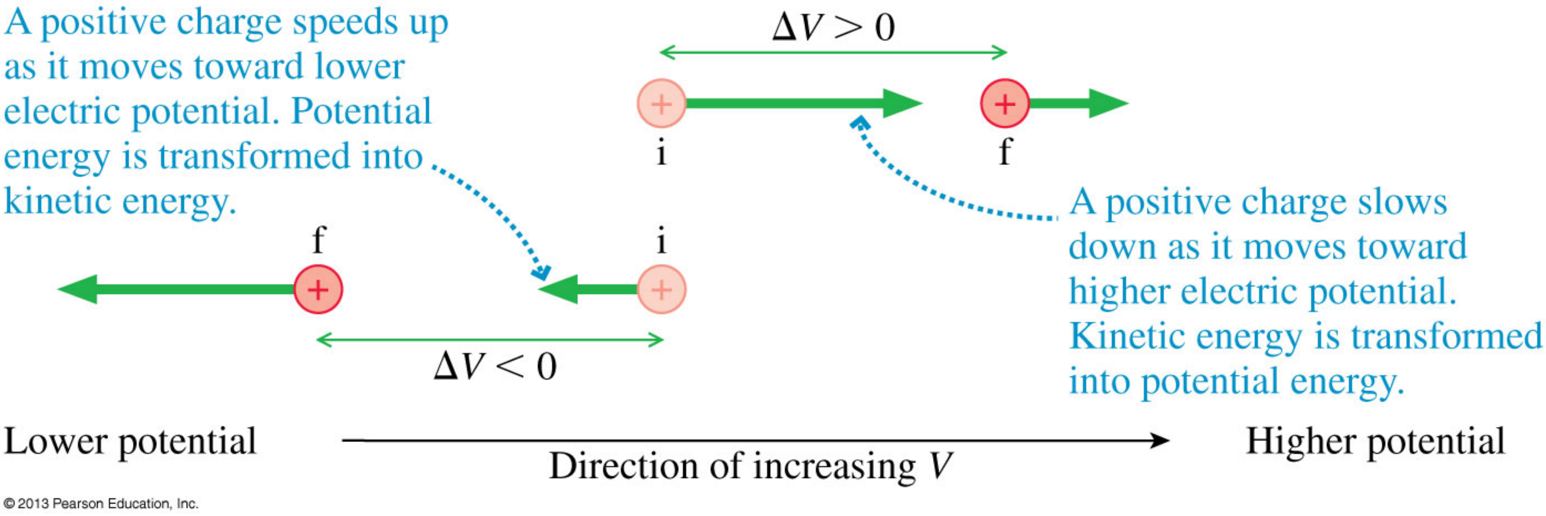
SI Units:

$$1\ Volt = 1V \equiv 1\frac{J}{C}$$

Notice:

- The *electric potential*, like the *E*-field, is a property of *source* charge(s).

Using the Electric Potential…



For $+q$ moving to the *right*:

- *V increases*, *U increases*, K *decreases*

For $+q$ moving to the *left*:

- *V decreases*, *U decreases*, K *increases*

- What about for a $-q$?

i.e. 28.6:
Moving through a potential difference

A proton with a speed of 2.0 x 10^5 m/s enters a region of space in which source charges have created an electric potential.

What is the proton's speed after it moves through a potential difference of 100V?

What will be the final speed if the proton is replaced by an electron?

$V_0 = 2.0 \times 10^5 \, m/s$

$\Delta V = 100V$

$V_2 = ?$

$m = 1.67 \times 10^{-27} \, Kg$

$q = 1.6 \times 10^{-19} \, C$

$V = \frac{u}{q}$

$K_0 + u_0 = K_1 + u_1$

$K_0 - (u_1 - u_0) = K_1$

$\Delta u = u_2 - u_1 = qV_2 - qV_1 = q(\Delta V)$

$\frac{1}{2} m v_0^2 - q(\Delta V) = \frac{1}{2} m v_1^2$

$\sqrt{\frac{m v_0^2 - 2q(\Delta V)}{m}} = v_1$

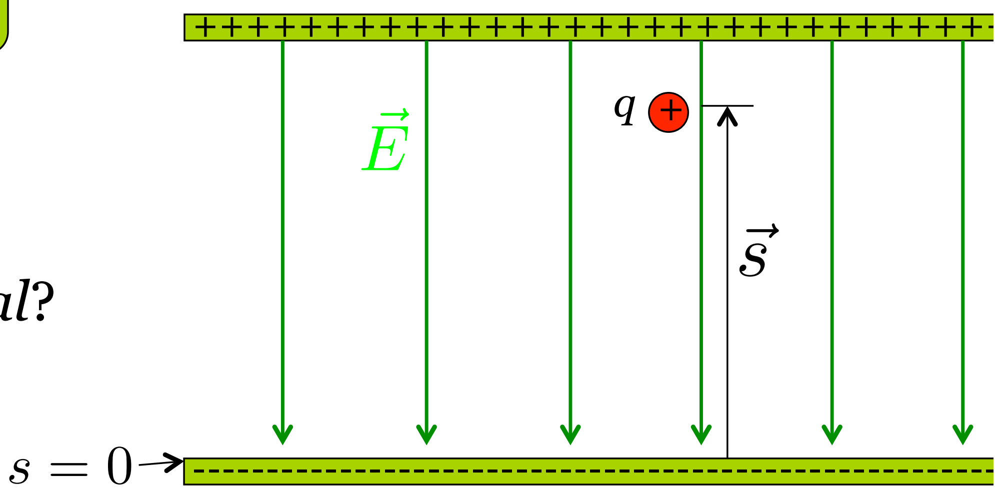
$v_1 = 1.4 \times 10^5 \, m/s$

28.5: The Electric Potential Inside a Parallel-Plate Capacitor

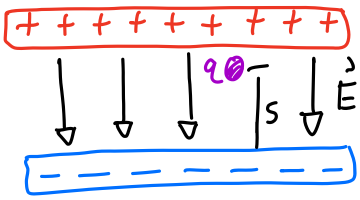
The *Electric Potential Energy* of a charge q in the *uniform E*-field of a parallel-plate capacitor is…

$$\boxed{U_{elec} = qEs}$$

- So, what's the *Electric Potential*?



Electric Potential Energy
Within Parallel Plate capacitor



$U_E = QES$

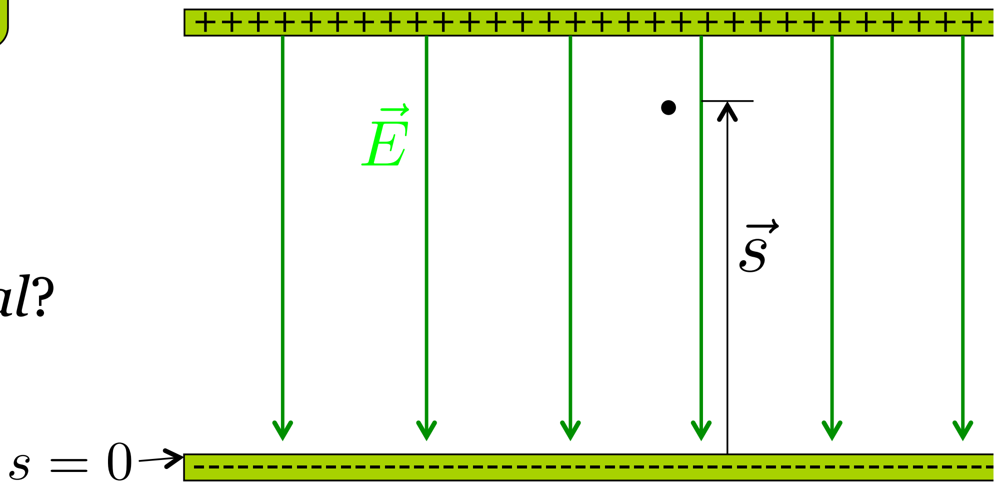
28.5: The Electric Potential inside a Parallel-Plate Capacitor

The *Electric Potential Energy* of a charge q in the *uniform E*-field of a parallel-plate capacitor is…

$$\boxed{U_{elec} = qEs}$$

So, what's the *Electric Potential*?

$$\boxed{V = Es}$$

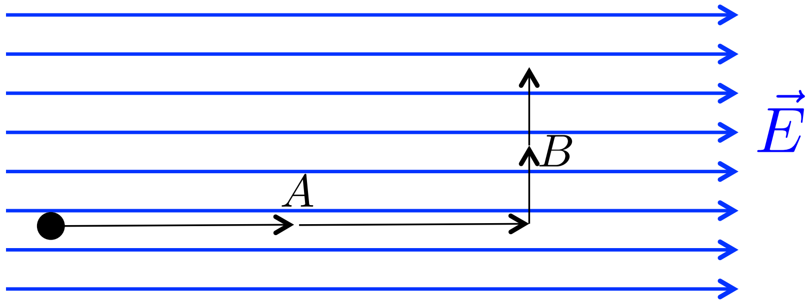


where s is the distance from the *negative electrode*.

Quiz Question 1

A *negative* charge is moving through an *electric field* along a path consisting of 2 legs (A & B). Let W represent the work done by the field, and ΔV the change in potential.

Which of the following statements is/are true:



I. $W_A > 0$

II. $W_B > 0$

III. $\Delta V_A < 0$

IV. $\Delta V_A > 0$

1. I only
2. I and II
3. III only
4. I and III
5. II and IV